

CLAIMS:

1. A high capacity switch for switching communications traffic, the high capacity switch having:
  - 5 a plurality of differing granularity switching levels, each switching level having at least one switch node capable of performing a switching operation at the granularity of the switching level; and
  - at least two primary connections, each connecting one of the switching levels to another one of the switching levels, wherein
  - 10 at one of the switching levels, at least one switch node is capable of switching communications traffic along at least one switch connection path established along one of the primary connections, and is capable of switching communications traffic along at least one secondary connection to another switch node within the same switching level, such that each of the at least one
  - 15 switch connection paths established is filled to a predetermined level.
2. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the pre-determined level is the maximum traffic capacity of the switch connection path.
- 20 3. A high capacity switch for switching communications traffic as claimed in claim 1, wherein each at least one secondary connection is configured to have a traffic capacity so that the high capacity switch is non-blocking.
- 25 4. A high capacity switch for switching communications traffic as claimed in claim 1, wherein at least one secondary connection comprises a permanent connection.
- 30 5. A high capacity switch for switching communications traffic as claimed in claim 1, wherein every secondary connection comprises a permanent connection.
- 35 6. A high capacity switch for switching communications traffic as claimed in claim 1, wherein one of the switching levels which performs the coarsest granularity switching operation has one switch node.

- 5 7. A high capacity switch for switching communications traffic as claimed in claim 1, wherein each switch node in one of the switching levels comprises a plurality of switches, each switch being capable of operating at the granularity of the one of the switching levels.
- 10 8. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the traffic capacity of the at least one secondary connection in a first one of the switching levels is determined by the capacity of the at least one switch connection path to a second, coarser, one of the switching levels which is capable of providing a coarser granularity switching operation than the first one of the switching levels.
- 15 9. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the traffic capacity of the at least one secondary connection in a first one of the switching levels is substantially the same as the capacity of the at least one switch connection path to a second one of the switching levels which is capable of providing a coarser granularity switching operation than the first one of the switching levels.
- 20 10. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the traffic capacity of the at least one secondary connection in a first one of the switching levels is larger than the capacity of the at least one switch connection path to a second one of the switching levels which is capable of providing a coarser granularity switching operation than the first one of the switching levels.
- 25 11. A high capacity switch for switching communications traffic as claimed in claim 1, having two differing granularity switching levels.
- 30 12. A high capacity switch for switching communications traffic as claimed in claim 1, having three differing granularity switching levels.
- 35 13. A high capacity switch for switching communications traffic as claimed in claim 1, having more than three differing granularity switching levels.

5 14. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch has two differing granularity switching levels, the traffic capacity of the at least one secondary connection in a one of the switching levels providing a finer granularity switching operation may be approximately equal to the granularity of a switching operation in a one of the switching levels providing a coarser granularity switching operation.

10 15. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch has three different granularity switching levels, the traffic capacity of the at least one secondary connection in one of the switching levels providing a finest granularity switching operation may be approximately equal to the granularity of a  
15 switching operation in one of the switching levels providing an intermediate granularity switching operation, and the traffic capacity of the at least one secondary connection in the one of the switching levels providing an intermediate granularity switching operation may be approximately equal to the granularity of the switching operation of in one of the switching levels  
20 providing a coarsest granularity switching operation.

25 16. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch is capable of switching traffic which is coarser than the granularity of the switching operation provided by a switch node in a first one of the switching levels by routing traffic through to a second one of the switching levels which is capable of providing a coarser granularity switching operation than the operation provided by the first one of the switching levels.

30 17. A high capacity switch for switching communications traffic as claimed in claim 1, wherein at least one switch node of a one of the switching levels which provides the coarsest granularity switching operation is capable of establishing at least one secondary connection between a pair of switch nodes in a second one of the switching levels which provides a finer  
35 granularity switching operation.

- 5 18. A high capacity switch for switching communications traffic as claimed in claim 1, wherein at least one secondary connection is provided externally to a one of the switching levels which provides the coarsest granularity switching operation.
- 10 19. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the switch node of a one of the switching levels which provides the coarsest granularity switching operation includes an optical switch.
- 15 20. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the switch node of a one of the switching levels which provides the coarsest granularity switching operation is transparent to the type of traffic.
- 20 21. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch is capable of switching both time division multiplexed traffic and wavelength multiplexed traffic.
- 25 22. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch is capable of switching SONET/SDH traffic.
- 30 23. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch is capable of switching both SONET/SDH and wavelength traffic.
- 35 24. A high capacity switch for switching communications traffic as claimed in claim 1, wherein at least one switch node is capable of switching a lower order SDH/SDH virtual container.
25. A high capacity switch for switching communications traffic as claimed in claim 1, wherein at least one switch node is capable of switching higher order SDH/SDH virtual containers .

- 5
26. A high capacity switch for switching communications traffic as claimed in claim 1, wherein at least one switch node is capable of switching a plurality of higher order SDH/SDH containers.
- 10
27. A high capacity switch for switching communications traffic as claimed in claim 1, wherein at least one switch node in one of the plurality of switching levels is capable of switching lower order virtual containers, and at least one other switch node in another of the plurality of switching levels is capable of switching higher order virtual containers.
- 15
28. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch according has at least three switching levels, at least one switch node in a first one of the plurality of switching levels may be capable of switching lower order virtual containers, and at least one switch node in a second one of the plurality of switching levels may be capable of switching higher order virtual containers, and at least one switch node in a third one of the plurality of switching levels may be capable of switching a plurality of higher order virtual containers.
- 20
29. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch is distributed over a communications network.
- 25
30. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the high capacity switch is incorporated into a telecommunications network.
- 30
31. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the switch is capable of bypassing traffic routed through the switch through a first one of the switching levels so that the traffic is switched by a second one of the switching levels capable of performing a coarser granularity switching operation than the first one of the switching levels.
- 35

- 5 32. A high capacity switch for switching communications traffic as claimed in claim 1, wherein the switch is capable of bypassing traffic routed through the switch through the at least one switch node of a first one of the switching levels so that the traffic is switched by one of the at least one switch nodes in a second one of the switching levels capable of performing a coarser granularity switching operation than the first one of the switching levels.
- 10 33. A switch of granularity M comprising:  
a switch core including a coarse grain switch of granularity N;  
a plurality of switch nodes, each switch node comprising at least one fine grain switch of granularity M finer than N, the switch core being capable of establishing a switch connection path with any of the switch nodes; and  
15 a plurality of permanent connections, each permanent connection connecting two fine grain switches, wherein the permanent connections are configured to permit the switch to be non-blocking, and wherein a minimum number of switch connection paths are established, the switch connections being filled to capacity with traffic routed through the switch  
20 and wherein residual traffic is routed along permanent connections.
- 25 34. A switch of granularity M as claimed in Claim 33, wherein the traffic capacity of each permanent connection between any pair of fine grain switches is substantially equals to the granularity N of the coarse grain switch.
- 30 35. A method of controlling traffic to be routed through a high capacity switch according to the first aspect of the invention, the method comprising the steps of:  
assessing traffic received at a switch node in a finer granularity switching level;  
at the switch node in the finer granularity switching level, switching traffic capable of filling to capacity an exact number of switch connections along a primary connection along the exact number of switch connections to a  
35 next coarser granularity switching level switch node,

switching residual traffic not capable of filling a switch connection to capacity along a secondary connection to another switch node in the finer granularity switching level; and

reconfiguring the number of switch connections established in accordance with any variation in the traffic to ensure that a minimum number of switch connections is always established from the finer granularity switching level to the next coarser granularity switching level.

36. A method as claimed in Claim 35, wherein the step of reconfiguring uses a hitless technique.

37. A method as claimed in Claim 35, wherein the step of reconfiguring maintains the synchronization of traffic at a destination.

38. A communications network including a high capacity switch for switching communications traffic, the high capacity switch having:  
a plurality of differing granularity switching levels, each switching level having at least one switch node capable of performing a switching operation at the granularity of the switching level; and  
at least two primary connections, each connecting one of the switching levels to another one of the switching levels, wherein at one of the switching levels, at least one switch node is capable of switching communications traffic along at least one switch connection path established along one of the primary connections, and is capable of switching communications traffic along at least one secondary connection to another switch node within the same switching level, such that each of the at least one switch connection paths established is filled to a predetermined level.

39. A switch node forming part of a high capacity switch for switching communications traffic, the high capacity switch having:  
a plurality of differing granularity switching levels, each switching level having at least one switch node capable of performing a switching operation at the granularity of the switching level; and

5

at least two primary connections, each connecting one of the switching levels to another one of the switching levels, wherein at one of the switching levels, at least one switch node is capable of switching communications traffic along at least one switch connection path established along one of the primary connections, and is capable of switching communications traffic along at least one secondary connection to another switch node within the same switching level, such that each of the at least one switch connection paths established is filled to a predetermined level.